



Recovery Act Program Plan

Astrophysics Research Within the **American Recovery and Reinvestment Act of 2009**

June 15, 2010

Introduction

This is the plan for Astrophysics Research, funded by the American Reinvestment and Recovery Act (ARRA), under the Treasury Account Symbol (TAS) 80-0119.

NASA funded the James Webb Space Telescope (JWST) Project with \$75.0 million under the Recovery Act to maintain current workforce levels, complete critical work on schedule, and maintain the launch readiness date. Recovery Act funds were used in conjunction with existing JWST Project funds to complete the above planned activities. All work has been completed and all of the ARRA funds have been disbursed. This document reflects the final status and performance of the ARRA funded activities for this program.

Objectives

Program Purpose

The Astrophysics Program goal is to "Discover the origin, structure, evolution, and destiny of the universe and search for Earth-like planets." The purpose of the program is to conduct observations, research, and development in support of these goals. The James Webb Space Telescope (JWST) is a flagship mission to attain the Program's goals. For further information on this mission, go to <http://www.jwst.nasa.gov/>.

Public Benefits

Recovery Act funds for NASA's Astrophysics Program, which will be applied to the JWST Project, will assure job retention on this flagship mission, maintain the schedule of key development activities, and improve the likelihood of launching on the planned date, to begin the collection of science.

The Astrophysics Program has contributed to major advances in astronomy and has yielded significant scientific discoveries about the universe. The Program seeks to answer the questions that humankind has been pondering for centuries: How did the universe begin? How will it end? What are the limits of matter and energy, of space and time? How did the universe come to be, and what are the laws of nature that have permitted life to arise in the universe? Throughout history, these questions have served as cornerstones of mythology and philosophy: thought provoking, but unanswerable. Now, with the aid of cutting-edge science and technology, the answers are within reach. For more information, see <http://nasascience.nasa.gov/astrophysics>.

JWST is one of the NASA missions to answer portions of these questions. This mission was identified by the National Research Council as a top priority new initiative for astronomy and physics for the decade. JWST is a large, space-based observatory, with a 6.5-meter primary mirror optimized for infrared wavelengths, which will complement and extend the discoveries of the Hubble Space Telescope. It will have longer wavelength coverage and greatly improved sensitivity. The longer wavelengths enable JWST to look further back in time to find the first galaxies that formed in the early Universe, and to peer inside dust clouds where stars and planetary systems are forming today.

JWST will be the premier observatory of the next decade, serving thousands of astronomers worldwide. It will study every phase in the history of our universe, ranging from the first luminous glows after the big bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own Solar System. When JWST becomes operational, it will significantly contribute to the public's and the scientific communities'

understanding of these questions.

Projects and Activities

Scope

The Astrophysics Program is an important program for NASA. This Program is comprised of multiple smaller programs and projects, including JWST. Recovery Act funds will be applied to the JWST for spacecraft development activities including design and fabrication of key component systems. These activities will increase the likelihood that the James Webb Space Telescope will launch on the planned date and become a giant leap forward in our quest to understand the Universe and our origins. This important observatory will examine every phase of cosmic history: from the first luminous glows after the big bang to the formation of galaxies, stars, and planets to the evolution of our own solar system.

NASA will fund JWST with \$75.0 million under the Recovery Act to maintain current workforce levels and the launch readiness date. Without this increase, significant workforce reductions would be necessary during this fiscal year, FY 2009, increasing cost and schedule risk. The resulting JWST budget profile (across all fiscal years) will be more consistent with the recommendations made by the independent JWST Standing Review Board, and provide for a more efficient use of the workforce currently in place. Several spacecraft subsystems will be developed with this funding such as the Optical Telescope Element (OTE) backplane structure, which supports the OTE mirrors; wavefront sensing elements for aligning and focusing the telescope; and engineering models for design and testing of the primary mirror segment and the NIRCам Instrument, respectively. Specific deliverables are highlighted below in the Major Program Planned Milestones and the Performance Measures sections of this Program Plan.

Acquisition Characteristics

All work will be accomplished via existing contracts. The recipients of this work will be for-profit organizations*. The primary beneficiaries are the general public and its scientific and engineering communities.

Major Planned Program Milestones

JWST is planned for launch in June 2014. After undergoing an intensive technical, schedule, and cost assessment process, the project was confirmed to proceed into development in July 2008; and, it is currently finalizing the design of the entire spacecraft system, consisting of both the satellite observatory in-space and the supporting ground control system. The observatory prime contractor is completing the design and manufacturing plans for the Sunshield, Optical Telescope Element (OTE), and Spacecraft Bus (which provides the physical platform and necessary support functions for the operation of a spacecraft). Multiple spacecraft sub-systems will be developed in the next two years with Recovery funding, which are outlined below along with key milestone dates. These designs will be formally reviewed at the Mission Critical Design Review (CDR) in the First Quarter of Calendar Year 2010. The CDR will be used to demonstrate that the maturity of the instrument and spacecraft subsystems design is appropriate to support proceeding with full-scale fabrication, assembly, integration, and test.

JWST will have a large mirror, 6.5 meters (21.3 feet) in diameter, and a sunshield the size of a tennis court. Both the mirror and sunshade will not fit onto the rocket fully open, so both will fold

* Although significant previous work was performed by small businesses, all of the remaining JWST activity is expected to be performed by larger organizations.

up, and open once JWST is in outer space. JWST will reside in an orbit about 1.5 million km (1 million miles) from the Earth. The Optical Telescope Element or OTE is the "eye" of the Webb Observatory. The telescope consists of the 6.5-meter primary mirror; secondary, tertiary, and fine steering mirrors; and supporting structures, deployable tower and control electronics. A large deployable sunshade shields the optics, as if an umbrella is keeping the telescope chilled - 370 degrees Fahrenheit to -298 degrees Fahrenheit, which allows it to see the faint infrared glow of distant objects. Instruments located behind the mirror will record stellar images and spectra. These instruments include a Near-Infrared Camera, a Near-Infrared Spectrograph, a Fine Guidance Sensor with Tunable Filter Module, and a Mid-Infrared Instrument.

Note the following milestones are subject to change, based on the complex and highly dynamic nature of research and development-type activities.

For a view of the conceptual design and actual photographs of the JWST systems, discussed below, see <http://www.jwst.nasa.gov/about.html>.

Milestone 1: Complete Optical Telescope Element (OTE) Backplane Critical Design Audit.

A Critical Design Audit is a review held for long-lead items that need approval to start fabrication before the associated Critical Design Review is held. The OTE Backplane Structure precisely supports and holds the OTE mirrors. The Webb telescope is as tall as a two-story house, and the Backplane supports the telescope's 21-foot diameter (6.5 meter) primary mirror. The OTE Backplane design will be completed and formally reviewed at its Critical Design Audit (CDA).

Expected Completion Date for Milestone 1: Third Quarter, Calendar Year 2009

Actual Completion Date for Milestone 1: September 2009 (Third Quarter, Calendar Year 2009)

Milestone 2: Complete Mission Critical Design Review (CDR).

This CDR will be used to demonstrate that the maturity of all aspects of the mission, including the instrument and spacecraft subsystems designs, are appropriate to support proceeding with full-scale fabrication, assembly, integration, and test.

Expected Completion Date for Milestone 2: First Quarter, Calendar Year 2010

Actual Completion Date for Milestone 2: April 2010 (Second Quarter, Calendar Year 2010)

Reason for Change: The CDR was moved from late March to early April to accommodate senior management schedules, with no impact to the mission schedule.

Milestone 3: Complete NIRCam Engineering Test Unit.

The Near Infrared Camera (NIRCam) is an imager with a large field of view and high angular resolution. The NIRCam is a science instrument but also an Optical Telescope Element wavefront sensor, which provides something similar to instant LASIK vision correction. The build up, test, and delivery of the NIRCam Instrument Engineering Test Unit will be completed. Engineering test units are used to demonstrate critical aspects of the engineering processes involved in the development of the operational space flight unit. Engineering test units closely resemble the final product (hardware/software) to the maximum extent possible and are built and tested so as to establish confidence that the design will function in the expected environments.

Expected Completion Date for Milestone 3: Fourth Quarter, Calendar Year 2010

Actual Completion Date for Milestone 3: May 2010 (Second Quarter, Calendar Year 2010)

Monitoring and Evaluation

NASA uses multiple methods, processes, and entities for monitoring and evaluating its performance. These same processes and procedures will be used for activities funded under the Recovery Act. NASA's programs are assessed for relevance, quality, and performance. A relevance review assures alignment with national priorities; alignment with the NASA Strategic Plan; impact on related fields of research or technology; and alignment with "customer" (users of NASA data, research results, etc.) needs. Determining quality is generally prospective and assures "best value" for an investment, using peer review processes. Performance reviews evaluate whether a program is on track to meet its baseline performance commitments (cost, schedule, science/technical deliverable).

Reviews are conducted internal and external to the Agency. Entities such as the NASA Advisory Council (NAC) and the National Research Council perform external evaluations to assess NASA's program content and direction. Additional independent reviews are commissioned by the NASA Administrator or responsible mission organization to review programs for relevance and quality, as well as performance. Reviews are rigorous and methodical, and focused on the program's methods, results, and findings by others in the field with requisite expertise, and independence.

Responsibility for program and project management and their control mechanisms (NASA Procedural Requirements[†] (NPR) 7120 series), institutional management (NPR 8500 series), and financial management (NPR 9010 and 9120 series), occurs at all management levels of the Agency. NASA's management monitors different aspects of program or institutional performance, at the highest Agency levels, and uses a rigorous structure of program and management reviews for Agency-level decisions. To continue through each phase of development, programs must demonstrate, on an on-going basis and at key lifecycle junctures, an ability to manage in a manner that produces identifiable results, and must document performance against previously defined commitments including multi-year outputs, annual performance goals, milestones, and other metrics, as appropriate.

NASA internally monitors performance through monthly and quarterly reviews, at each management level. At the senior management level, program reviews, accompanied by an independent (internal) assessment, occur across all mission areas (aeronautics, science, space operations and exploration systems), and with an in-depth review each quarter rotating among the mission organizations. Senior management also reviews institutional data (finance, human capital, acquisition, infrastructure), and aggregated Agency measures and metrics, e.g., safety, crosscutting technical and non-technical issues. The data reviewed, and the accompanying analysis, allows the Agency to focus on, and proactively address, issues that could lead to not achieving desired performance goals.

Specific to the Astrophysics Program, monthly and quarterly reviews are conducted to gather and analyze performance data from all participating organizations (including contractors) and compare against expected baseline performance data. JWST, as an Astrophysics project, is subjected to all of the requirements of the program and will follow the above processes. JWST will be reviewed monthly for cost versus plan, schedule movement, mass and power margins, estimate to complete assessments, and available budget versus estimated costs remaining, often with the aid of earned value assessment. More detailed quarterly reviews are conducted for all space flight projects. This information is used to assess progress toward meeting long-term outcomes and goals, develop risk mitigation strategies, adjust priorities, and/or make

[†] The [NASA Online Directives Information System Library](#), ensures access by NASA employees and contractors to the most current documentation.

resource allocations. Independent review for achieving performance outcomes will occur at major program milestones during development.

Performance Measures

Table 1

| Measure Description | Maintenance of established schedule for development of spacecraft subsystems in support of the James Webb Space Telescope 2014 Launch Readiness Date. |
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| Explanation of Measure | <p>Complete James Webb Space Telescope spacecraft subsystems development milestones within 10% of projected schedule. The combined schedule for completion of the Optical Telescope Element Backplane Critical Design Audit, Mission Critical Design Review, and the NIRCams Engineering Test Unit, from the June 2009 receipt of ARRA funds to completion is the equivalent of 30 months. For each update, NASA will confirm dates of completion for those milestones already achieved and planned completion dates for the remainder in order to provide the percentage of planned schedule within which milestones are/will be completed.</p> <p>NASA completes many spacecraft and instrument development activities that demonstrate progress toward providing the critical systems for the conduct of scientific research. Each year a series of activities are tracked for their successful completion. Generally, major system formulation activities consist of the completion of conceptual studies, requirements reviews, and preparation to proceed into the design and development phases of the project. Design and development activities consist of key design reviews and fabrication completion events, and eventual launch of the spacecraft.</p> <p>Further information on these key milestones may be found in Section 4, "Major Planned Program Milestones."</p> |
| Measure Type | Output |
| Measure Frequency | Quarterly |
| Original Program Target (without ARRA funds) | <p>Completion of the Optical Telescope Element Backplane Critical Design Audit, Mission Critical Design Review, and the NIRCams Engineering Test Unit mission milestones within 10% of the established schedule:</p> <p>Optical Telescope Element Backplane Critical Design Audit: September 2009</p> <p>Mission Critical Design Review: March 2010</p> <p>Completion of the NIRCams Engineering Test Unit: December 2010</p> |

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| Revised Program Target (with ARRA funds) | <p>Completion of the Optical Telescope Element Backplane Critical Design Audit, Mission Critical Design Review, and the NIRCam Engineering Test Unit mission milestones within 10% of the established schedule:</p> <p>Optical Telescope Element Backplane Critical Design Audit: September 2009</p> <p>Mission Critical Design Review: March 2010</p> <p>Completion of the NIRCam Engineering Test Unit: December 2010</p> |
| Estimated Incremental Change in Performance (due to ARRA funds, estimated on May 15, 2009) | Recovery Act funding, will increase the likelihood of maintaining these current milestones. |
| Actual Performance (as of May 31, 2010) | <p>Optical Telescope Element Backplane Critical Design Audit: September 2009</p> <p>Mission Critical Design Review: April 2010</p> <p>Completion of the NIRCam Engineering Test Unit: May 2010</p> <p><i>Reason for Change: The CDR was moved from late March to early April to accommodate senior management schedules, with no impact to the mission schedule. The other milestones remained on target or had an earlier completion date.</i></p> |
| Revised Program Target (due to ARRA funds, estimated on May 31, 2010) | No revised target is required due to the completion of these milestones, and this reflects the final performance of this program. |
| Goal Lead | Director, Astrophysics Division, Science Mission Directorate |
| Measure Description | Variance from the planned cumulative obligations for the Astrophysics Program. |
| Explanation of Measure | <p>A key aspect of the American Recovery and Reinvestment Act is to assure the timely obligation of funds to the intended beneficiaries. NASA plans to make every effort to assure this happens on the plan that it has put forward, which has been designed to also maintain a prudent use of taxpayer funds, and provide key research and development program deliverables to the benefit of the public. An obligation of funds means a binding agreement is made with NASA's contractors and grantees that will result in outlays (or a payment for the services or goods they provided), immediately or in the future. NASA will measure its progress toward the planned obligations to-date, on a quarterly basis.</p> <p>NASA's baseline obligation plan (when available) is posted at http://www.nasa.gov/recovery/.</p> |
| Measure Type | Output |

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| Measure Frequency | Quarterly |
| Original Program Target (without ARRA funds) | ±10% |
| Revised Program Target (with ARRA funds) | ±10% |
| Estimated Incremental Change in Performance (due to ARRA funds, estimated on May 15, 2009) | Not applicable. |
| Actual Performance (as of May 31, 2010) | The funds for the JWST Program activities were obligated according to their plan. |
| Revised Program Target (due to ARRA funds, estimated on May 31, 2010) | No revised target is required due to the completion of these milestones, and this reflects the final performance of this program. |
| Goal Lead | Director, Astrophysics Division, Science Mission Directorate |
| Measure Description | Variance from the planned cumulative outlays for the Astrophysics Program. |
| Explanation of Measure | <p>A key aspect of the American Recovery and Reinvestment Act is to assure the timely outlay of funds to the intended beneficiaries. NASA plans to make every effort to assure this happens on the plan that it has put forward, which has been designed to also maintain a prudent use of taxpayer funds, and provide key research and development program deliverables to the benefit of the public. An outlay of funds means a payment that fulfills an obligation and is the measure of Government spending. This is a payment for the services or goods the contractor or grantee provided. NASA will measure its progress toward the planned outlays to-date, on a quarterly basis.</p> <p>NASA's baseline outlay plan (when available) is posted at http://www.nasa.gov/recovery/.</p> |
| Measure Type | Output |
| Measure Frequency | Quarterly |
| Original Program Target (without ARRA funds) | ±10% |
| Revised Program Target (with ARRA funds) | ±10% |

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| Estimated Incremental Change in Performance (due to ARRA funds, estimated on May 15, 2009) | Not applicable. |
| Actual Performance (as of May 31, 2010) | The funds for the JWST Program activities were disbursed according to their plan. |
| Revised Program Target (due to ARRA funds, estimated on May 31, 2010) | No revised target is required due to the completion of these milestones, and this reflects the final performance of this program. |
| Goal Lead | Director, Astrophysics Division, Science Mission Directorate |

Transparency and Accountability

NASA uses multiple methods to assure transparency and accountability, and will apply these standard processes and procedures to activities supported by Recovery Act funds. The principle of transparency is applied to program and fund allocation planning methods, and in reporting, both internal and external to the Agency, of progress toward the resultant plans. NASA requires accountability at all levels of management and from all of its cost-sharing and non-cost sharing partners, contractors, and grantees for the timely delivery and quality of products.

Rigor is applied to NASA programs' design, structure, management, and funding to ensure that resources reach the intended beneficiaries and address the programs' purpose directly. Transparent, merit-based criteria and decision-making procedures are employed at multiple steps in this process. Governing documents, such as the NASA Strategic Plan and supporting mission specific plans, guide the activities of these programs and provide the context through which specific science and research objectives are formulated, investigations are solicited, and missions or activities that address them are planned. Missions are prioritized based on expert opinion such as Decadal Surveys on science, available budget resources, technological maturity, and partnership opportunities.

As explained in detail in the Monitoring and Evaluation Section of this Program Plan, NASA will employ multiple methods of review and evaluation of progress toward the goals of this Program Plan. Reviews assure that funds are applied as intended, and that programs meet commitments and objectives. Managers at all levels will be held accountable both via review of their progress and individual performance plans. At NASA, all employee performance plans for Federal managers include elements tied to the program plans for which they are responsible.

NASA will hold contractors accountable for the timely delivery and quality of products. Award fee reviews, where appropriate, will be performed on contracts and past performance evaluations are integral in solicitation criteria. Grants and cooperative agreements are subject whenever possible to deliverables and milestones that must be met in order to receive funding renewal. International and Federal government partners work in accordance with applicable Memoranda of Understanding (MoUs) and agreements, which generally detail schedule and performance commitments.

Contractor and government accounting systems are audited periodically to ensure compliance with government standards. Specific reports that record and track the obligation and

expenditure of program funds including contractor monthly and quarterly reports, reports on budget execution and budgetary resources, a year-end closing statement, and the annual Performance and Accountability Report. Additionally, NASA will cooperate with the Government Accountability Office and the NASA Office of Inspector General through various engagements and audits that monitor specific items regarding Recovery Act funds.

To assure transparency and accountability to the public and its key stakeholders, NASA will post its current plans, and outline any revisions to previous versions on the Agency Recovery Act website. Information will be available on key events, the status of on-going activities, outcomes of Inspector General Audits and the accomplishment of and performance toward, annual and long-term Recovery Program goals. Web links will be provided, where applicable to posted solicitations, awards, and grantee performance, among other relevant information. For this important information on NASA efforts surrounding its Recovery Act funds, see <http://www.nasa.gov/recovery/>.

Federal Infrastructure Investments

There are no plans to spend funds on federal infrastructure within the ARRA investment in the JWST Program.